Design and analysis of a Microstrip antenna for WLAN applications.

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Abstract

A **microstrip antenna** is an antenna fabricated using microstrip techniques on a printed circuit board [1]. It is very useful in advanced wireless communication systems because of their small size, low weight, low cost, high gain and directional radiation pattern. The designed square microstrip patch antenna has advantages of ease of fabrication, analysis and low cross polarization. The antenna is designed over the operating frequency of 2.4 GHz using the substrate material as FR4 (Er = 4.4) and can be used for ISM band [2] and WLAN applications.

Keywords- ISM *– Industrial, Scientific, Medical band.* ***FR4-*** *Fire resistant dielectric substrate.*

I.Introduction

The main aim of the proposed work is to design small size patch antenna for wireless embedded applications and to understand the problems that can arise in design that is more complex and its counter effects. Microstrip patch antenna is a key building in wireless communication and GPS. A patch antenna is a narrowband antenna and it consists of a flat rectangular sheet mounted over a larger sheet of metal called as ground plane.

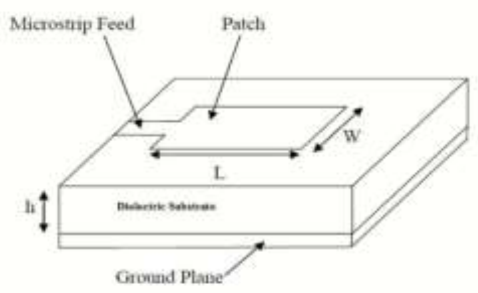

Fig 1:- 3D view of a patch antenna

Patch antenna is simple to fabricate and easy to modify and customize. Compared with conventional antenna microstrip patch antenna have advantages [3]. A microstrip patch antenna is well suited for wireless communication due to its lightweight, low cost and low planer configuration. The parameters such as return loss, voltage standing wave ratio, mutual coupling, gain, radiation pattern has been simulated and analysed. The design and simulations done using the Ansoft HFSSV15 and the return loss is less than -22dB.

II. Antenna Design

To meet those needs the plane square shape patch antenna chosen in order to reduce complexity and it can easily fit in any device. FR4 substrate used in the antenna as its dielectric material. The most important element is feeding the strip for connecting the probe to the antenna. The microstrip feed line method is used for better impedance matching[4] having the width 3.0389 mm and length of 15.6 mm as shown in figure The substrate (FR4) is mounted over the ground (Copper) and both have the same length and width of 47.21 mm and 38.76 mm respectively.

1. Width

$$W = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

2. Effective Dielectric constant

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(\frac{1}{\sqrt{1 + \frac{2h}{W}}}\right)$$

3. Effective length

$$L_{eff} = \frac{C}{2\, fr \sqrt{\varepsilon_{eff}}}$$

Where: c: velocity of light, 3*108 m/s,

εr :dielectric constant

fr : resonant frequency of antenna

The patch embedded on the Dielectric is 37.61 mm in length and 29.16 mm in width.

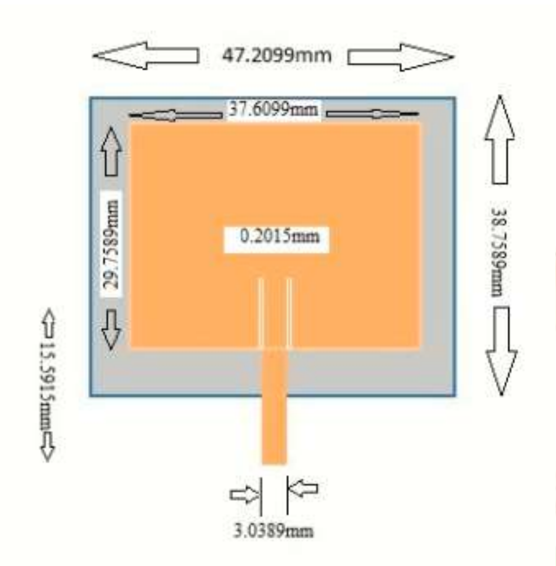

Fig 2:- Front view of the designed patch antenna

III. Simulated Results

The antenna parameters such as return loss, gain, voltage standing wave ratio (VSWR), radiation pattern, directivity and mutual coupling simulated using the software and then realised using the real patch antenna [5].

Return Loss

The loss of power in the signal returned by a discontinuity in a transmission line.

RL= -20 log [Ł]

Where,Ł is Reflection Coefficient

Our design provides return loss of -22.5 dB at 2.4 GHz. This indicates the proper functioning of the antenna in the desired frequency.

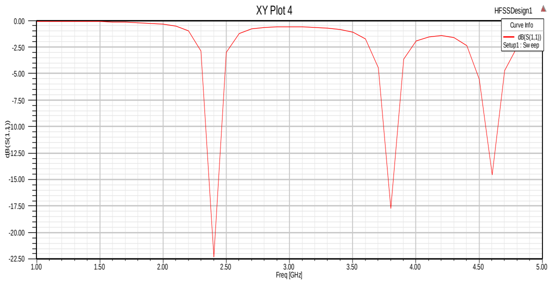

Fig 3:- VSWR result of simulation

Voltage Standing Wave Ratio (VSWR)

The measurement of the mismatch between the load and the transmission line is ideally 1 for better matching. The VSWR of designed antenna is 1.1 at 2.4GHZ.

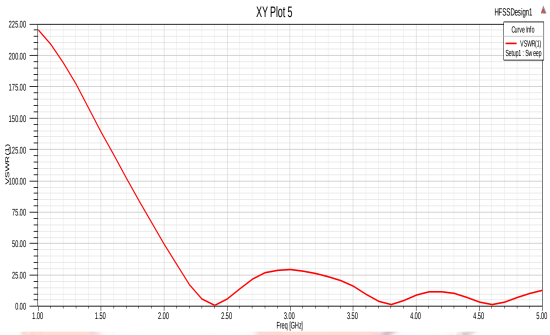

Fig 7:- VSWR of the designed antenna

Bandwidth

The range of frequency over which the antenna functions or radiates properly,

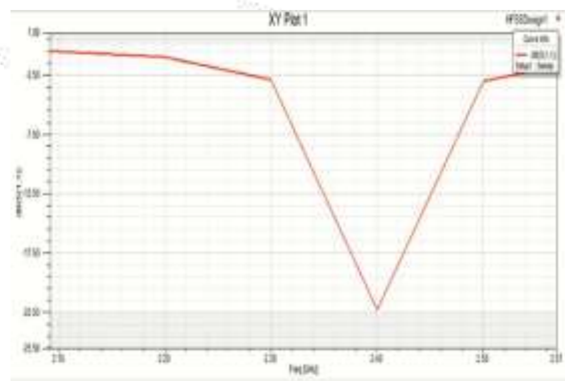

Fig 4:- Bandwidth of microstrip antenna

Here designed antenna provides bandwidth of 130MHz at 2.4GHz. That is the antenna radiates properly from 2335 MHz to 2465 Mhz hence allows flexibility to its frequency.

Gain

The designed antenna is unidirectional and thus its mail lobe radiated only in direction of its patch. The maximum gain achieved is 2.3dB due to its small size.

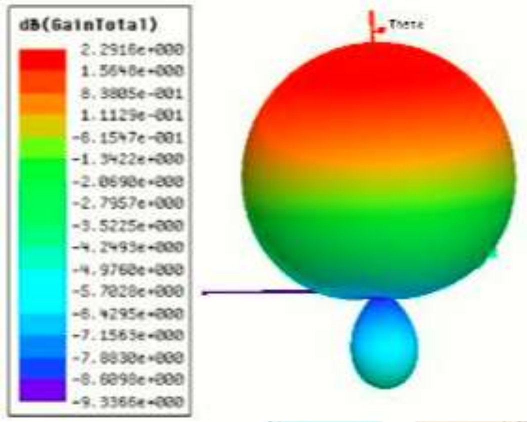

Fig 5:- Gain in dB

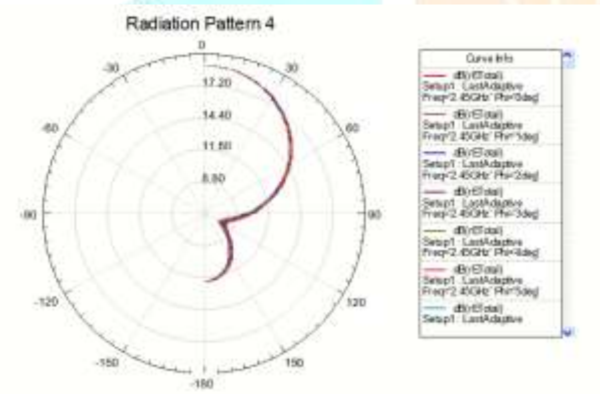

Fig 6:-Radiation pattern

IV. TESTED RESULTS

The above designed microstrip antenna is fabricated and tested in real environment.

Fig 8:- Testing of designed antenna in environment

The output parameters obtained after calculation are as follows:

P forward = -30dB

P reverse = -54dB

Return loss = 10 log (Pf/Pr) = -24 dB

$$\text{VSWR} = \frac{1+\sqrt{\frac{P_{rev}}{P_{fwd}}}}{1-\sqrt{\frac{P_{rev}}{P_{fwd}}}} = 1.13$$

V. CONCLUSION

A microstrip antenna is designed using Ansoft HFSS simulation software. The same antenna is designed and tested in practical environment. The obtained results are very close to the simulated results working efficiently in the 2.4GHz frequency. The designed antenna can be used efficiently for the ISM (Industrial, Scientific, Medical) band and has huge number of applications in modern telecommunication. Further, multiple antennas can be used to improve the transmission capacity and its performance can be studied in real environment.

VI. REFERENCES

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